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(54) Method and Apparatus for Production of Fibrous Sheet Material

(57) The method comprises dispersing fibres in a gas stream to obtain a gas/fibre stream, supplying the gas/fibre stream on to a flat screen, removing gas from the gas/fibre stream through said screen to form a fibrous layer thereon, and subsequently treating the layer to obtain a fibrous sheet material, wherein a part of the gas is removed from the gas/fibre stream prior to supplying it on to the flat screen, so as to bring the fibre concentration up to 20 to 500 g/m³. The concentration is chosen in accordance with the kind and properties of fibres. Simultaneously transversal pulsations induced in the gas/fibre stream in the course of its movement are damped. The apparatus comprises a slot nozzle 3 having parallel side walls 9, 10 which are normal to converging frontal walls 11, 12, its inlet opening being connected with a means for dispersing fibrous in a gas stream, while its outlet opening is connected with a chamber 4, a flat screen 5 which collects a fibrous layer is mounted under said chamber, and a suction box 6 is arranged underneath the flat screen, a means 13 for removing a part of gas from the gas/fibre stream is arranged in the chamber under the outlet opening of the slot nozzle, and the chamber is provided with branch pipes 15 for gas exhaust, mounted in the upper portion of the chamber.

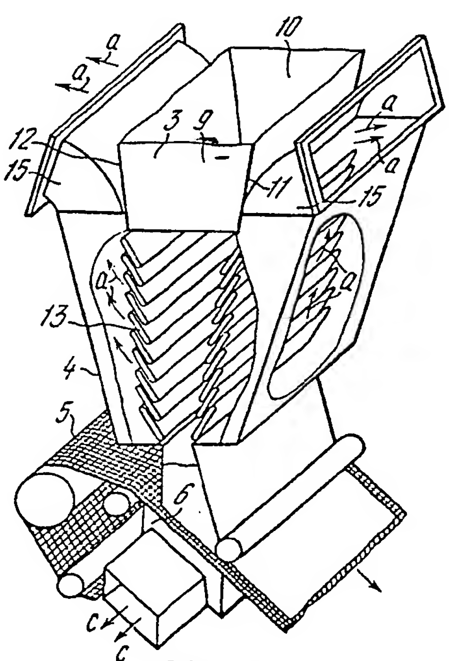

FIG. 7

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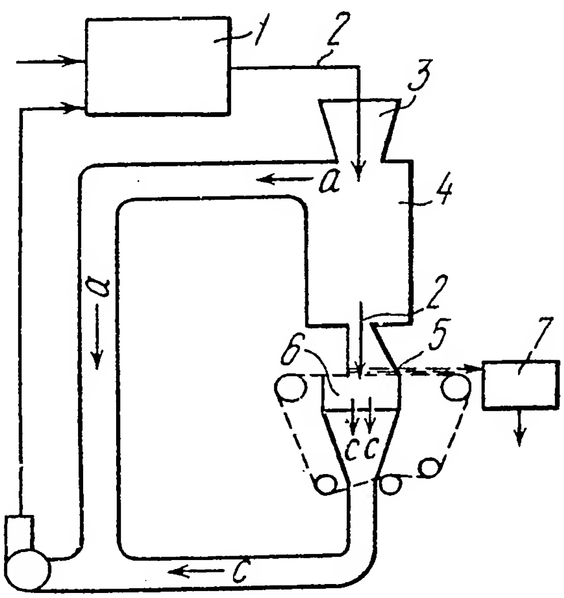

FIG.1

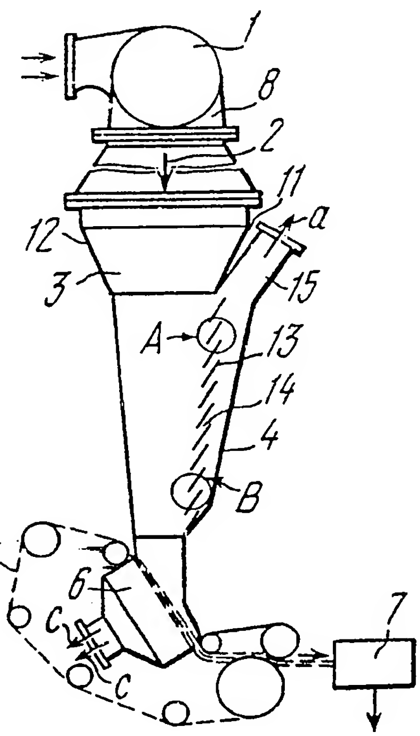

FIG. 2

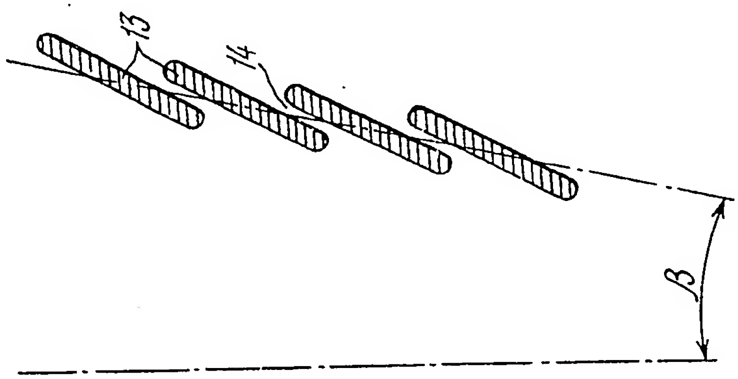

FIG. 5

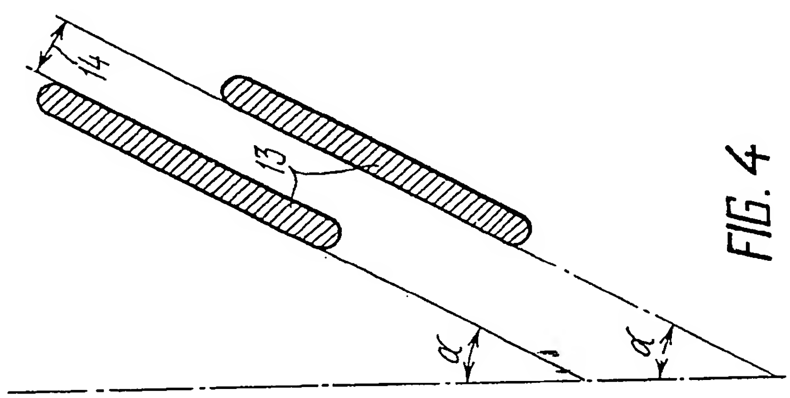

FIG. 4

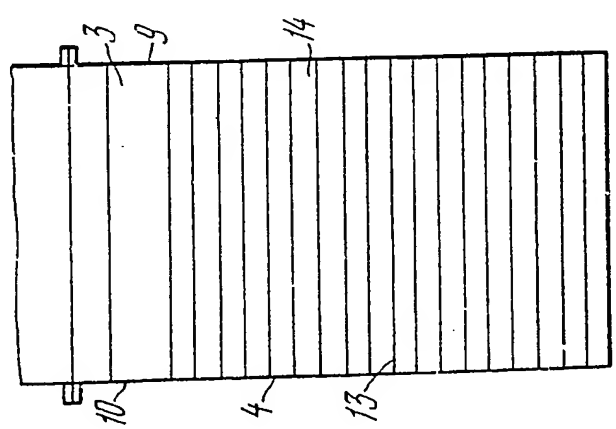

FIG. 3

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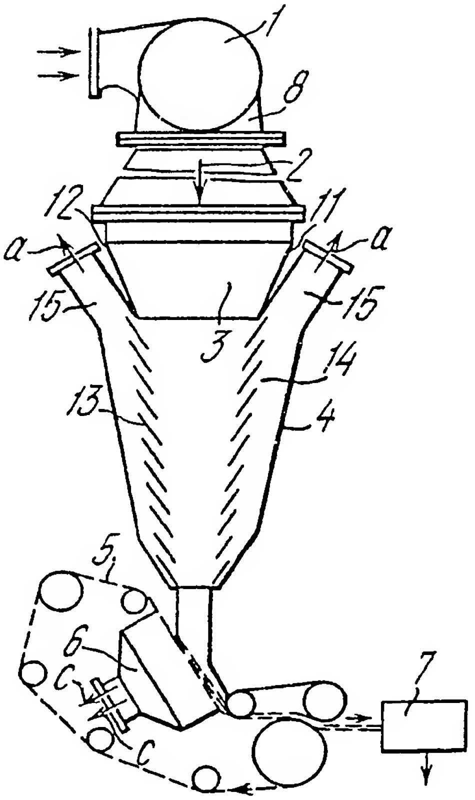

FIG. 6

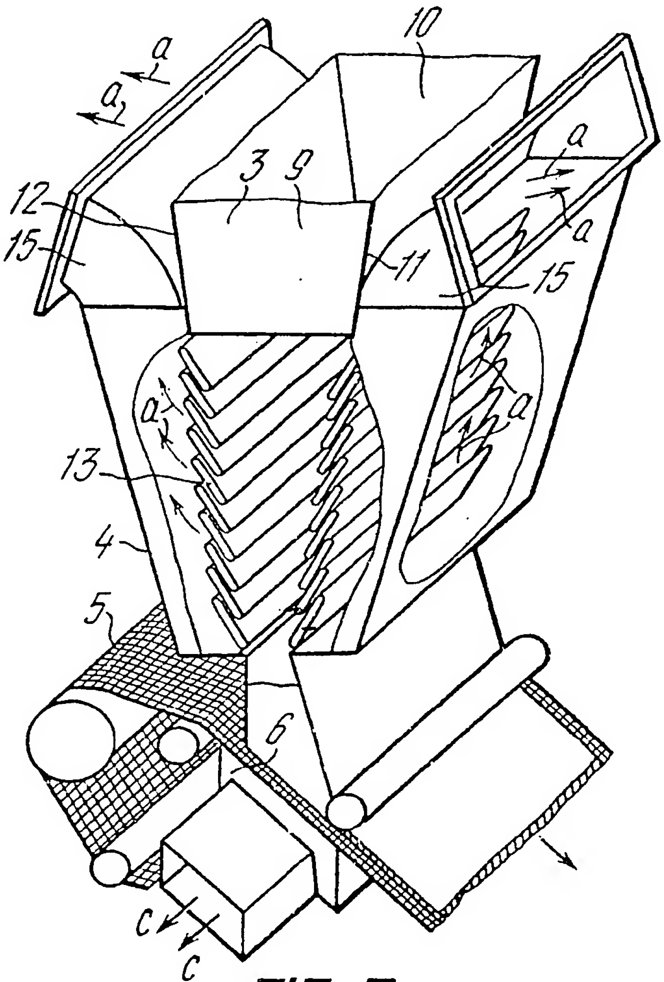

FIG. 7

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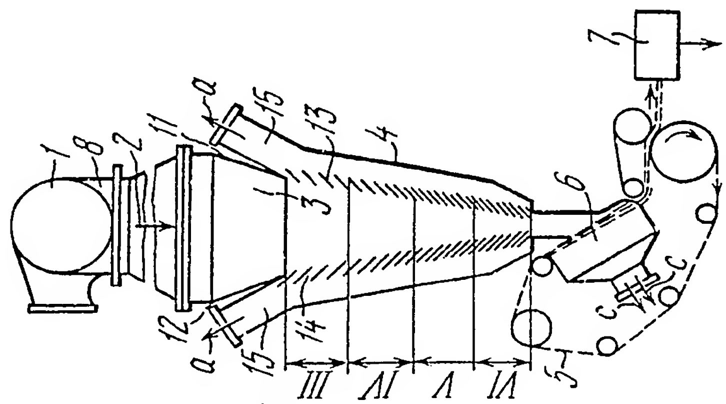

FIG.10

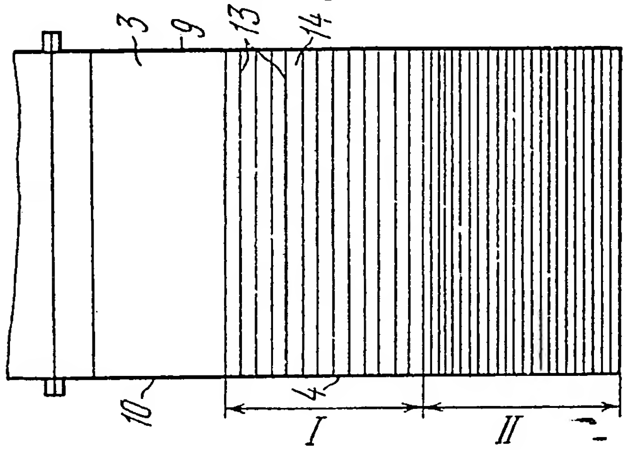

FIG.9

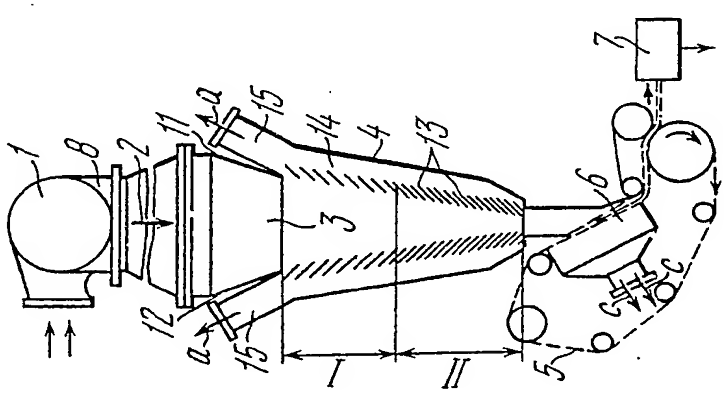

FIG.8

SPECIFICATION

Method and Apparatus for Production of Fibrous Sheet Material

The present invention relates in general to the processing of fibres, and more particularly to a method for production of fibrous sheet materials and apparatus for carrying out the method.

The present invention can most advantageously be used in the pulp-and-paper, textile and construction-material industries for producing various kinds of paper, board, non-woven fabric, felt, or construction board.

According to the invention there is provided a method for production of fibrous sheet material, comprising dispersing supply of a gas/fibre stream on to a flat screen, removal of gas from the gas/fibre stream through said screen to form a fibrous layer thereon, and any subsequent treatment necessary to obtain a fibrous sheet material, wherein a part of the gas is removed from the gas/fibre stream prior to supplying it on to the flat screen so as to bring the fibre concentration in the gas/fibre stream up to from 20 to 500 g/m³, the concentration being chosen in accordance with the kind and properties of the fibres, and transversal pulsations induced in the gas/fibre stream during movement are damped.

The gas/fibre stream is transformed according to the present method so that its fibre concentration increases from say 5.0—50 g/m³ to 20—500 g/m³. This increase occurs due to the existence of motion of the fibres with respect to the gas, whereby the fibres approach each other in a regular manner resulting in increases in the local fibre concentration. Therefore, a part of the gas which is low in fibres may be removed independently of the part of the gas saturated with fibres.

Due to the provision of damping of transversal pulsations induced in the gas/fibre stream, a sheet material of homogeneous structure can readily be obtained, this being achieved by virtual elimination of local flocculation which might otherwise take place in the gas/fibre stream as its fibre concentration increases.

It is advisable to keep within the limits ranging from 20 to 90 percent the amount of gas being removed from the gas/fibre stream prior to its supply on to the flat screen.

It is also desirable to damp the transversal pulsations by contracting the gas/fibre stream in the direction normal to the path of the stream movement.

The contraction or restriction of the gas/fibre stream in the direction normal to the path of the stream provides for confused flow of the stream with uniform distribution of the velocity field profile. This contributes to uniform regular fibre thickening and to reduction of the cross-stream component in the stream turbulence.

According to the invention there is also provided an apparatus for carrying out the method for production of fibrous sheet material, the apparatus comprising a slot nozzle having side walls normal to converging frontal walls, an inlet opening of ssid nozzle being connected with dispersing fibres in a gas stream and its outlet opening being connected with a chamber, a flat screen mounted under said chamber, for forming a fibrous layer, and a suction box arranged under the flat screen, wherein the side walls of the slot nozzle are in parallel relationship with respect to each other, means for removing a part of the gas from the gas/fibre stream is arranged within the chamber below the outlet opening of the slot nozzle, and the chamber is provided with branch pipes for gas exhaust which pipes are mounted substantially in the upper portion of the chamber.

The parallel arrangement of the side walls of the slot nozzle eliminates any considerable elongation of the velocity field profile, i.e. provides for uniform distribution of the velocity field profile.

Owing to the provision under the outlet opening of the slot nozzle of the means for removing a part of the gas from the gas/fibre stream, gas removal through the branch pipes arranged in the upper portion of the chamber is achieved, whereby the fibre concentration of the stream increases while expenditure of the current consumed in dividing the media during the process of forming the fibrous layer is reduced.

According to one embodiment of the invention, the means for removing a part of the gas from the gas/fibre stream is embodied as a plurality of guiding bodies arranged in parallel one under the other and spaced apart, preferably by 3 to 20 mm, so as to form a vertical row disposed under one of the frontal walls of the slot nozzle and inclined at 3.5° to 11° relative to the axis of the slot nozzle, each of the guiding bodies being inclined with respect to the axis of the slot nozzle at an angle ranging between 10° and 35° in the direction of gas fibre stream movement.

The means for removing a part of the gas from the gas/fibre stream when made as a plurality of guiding bodies arranged in parallel one under the other to form a vertical row disposed under one of the frontal walls of the slot nozzle, inclined at a particular angle with the respect to the axis of the slot nozzle, develops resistance to the gas/fibre stream leaving the outlet opening of the slot nozzle, whereby a part of the gas changes its initial direction and is gradually removed when passing through gaps between the guiding bodies as the gas/fibre steam flows along the row of guiding bodies.

Due to the provision of gradual removal of gas through the gaps between the guiding bodies, the fibre concentration of the stream increases, thus contributing to uniform distribution of the velocity field profile of the gas/fibre stream.

Owing to the inclination of the row of the guiding bodies with respect to the axis of the slot nozzle, the gas/fibre stream is contracted as it flows along the guiding bodies, thus increasing homogeneity of the gas/fibre stream.

According to another embodiment of the invention, the means for removing a part of the

gas from the gas/fibre stream is made as a plurality of guiding bodies arranged in parallel one under the other and spaced apart, preferably by 3 to 20 mm, so as to form two vertical rows, each disposed under one frontal wall of the slot nozzle and inclined at 3.5° to 11° with respect to the axis of the slot nozzle, each of said guiding bodies being inclined relative to the axis of the slot nozzle at an angle ranging between 10° and 35° in the direction of the gas/fibre stream movement, while the guiding bodies of one row are in a mirror-image disposition with respect to the guiding bodies of the other row.

Such a design of the means for removing a part of gas from the gas/fibre stream, incorporating guiding bodies arranged in parallel one under the other so as to form two vertical rows, each of the rows being disposed under one frontal wall of the slot nozzle, effectively enables the length of active zone through which gas is removed to be doubled, thus permitting reduction in size of the unit while maintaining the production output at the same level.

Due to the converging arrangement of the guiding bodies, contracting of the gas/fibre stream is effected in the direction normal to the direction of its movement, whereby transversal pulsations are partially damped. It is advisable to make the guiding bodies in the form of blades. Owing to the blade form of the guiding bodies, the gas/fibre stream is then notably prevented from fibre loss when a part of the gas is being removed.

It is advisable to arrange the guiding bodies of each row so as to form at least two groups of blades or other bodies and to provide equal gaps between the guiding bodies in each group, the gaps between the guiding bodies of the upstream group being greater than the gaps between the guiding bodies of the or the next downstream group.

Due to the provision of two groups of guiding bodies in each row, said guiding bodies in each group being equally spaced from each other and the gaps between the guiding bodies of the upstream group being greater than the gaps between the guiding bodies of the downstream group, removal of a part of gas without fibre loss is better ensured as the gas/fibre stream flows along the row of guiding bodies.

The gap between the guiding bodies of the upstream group should not exceed 20 mm, while the gap between the guiding bodies of the downstream group should not be under 3 mm.

The invention will now be explained in greater detail by way of example with reference to embodiments thereof which are represented in the accompanying drawings, wherein:

Figure 1 is a schematic flow diagram illustrating a method for production of fibrous sheet material, the method being according to the present invention;

Figure 2 is a vertical elevation of an apparatus which utilises the method of the invention for production of fibrous sheet material and is itself according to present invention;

Figure 3 is a face view of a row of blades of the apparatus of Figure 2;

Figure 4 is an enlarged view of the assembly A shown in Figure 2;

Figure 5 is an enlarged view of the assembly B shown in Figure 2;

Figure 6 is a vertical elevation of an alternative form of an apparatus according to the invention for carrying out the present method for production of fibrous sheet material;

Figure 7 is a partially cut-away perspective view of the apparatus of Figure 6j;

Figure 8 is a vertical elevation of another embodiment of an apparatus according to the invention for carrying out the present method for production of fibrous sheet material;

Figure 9 is a face view of a row of blades of the apparatus of Figure 8;

Figure 10 is a vertical elevation of yet another embodiment of an apparatus according to the invention for carrying out the present method for production of fibrous sheet material.

A method in accordance with the invention for production of fibrous sheet material is illustrated by the flow diagram shown in Figure 1. Fibrous material and gas are supplied to a dispersing means 1 for dispersing the fibres in a stream of the gas, whereby a gas/fibre stream 2 is obtained. The resultant gas/fibre stream 2 is delivered through a slot nozzle 3 into a chamber 4. Within the chamber 4 the gas/fibre stream 2 is restricted and contracts, and due to inertia forces, relative motion of gas and fibres is developed. When the gas/fibre stream is restricted, the gas and fibres move in different directions due to the fact that the density of the fibrous material is far more typically 800 times more than that of the gas. The fibres travel along a path coinciding with the initial path of the gas/fibre stream 2, while as shown by the arrows "a" a part of the gas, free of fibres, starts to move in a direction different from the initial direction of the gas/fibre stream 2. With the fibre/free part of the gas removed, the fibre concentration of the remaining stream increases.

The gas/fibre stream 2 is restricted in the direction normal to the direction of its movement, whereby transversal pulsations induced in the gas/fibre stream are gradually damped. Thus uniformity in the velocity field profile of the fibrous material in the gas/fibre stream, as well as a small-scale turbulent structure, are achieved. This, in turn, ensures a high fibre concentration and, at the same time, a homogeneous gas/fibre stream after passage through the chamber 4.

The gas fibre stream 2 is further delivered from the chamber 4 on to a flat screen 5, and the remaining part of gas is removed by a suction box 6 mounted under the flat screen 5. The direction of the gas removed from the gas/fibre stream 2 when the stream is being laid on the flat screen 5 is indicated by the arrows "c". The fibrous layer settled on the flat screen 5 is then subjected to appropriate treatment to obtain a finished fibrous sheet material.

The part of gas removed from the gas/fibre

stream 2 in the chamber 4, and that removed from the flat screen 5, may be re-used by feeding them into dispersing means 1 without any additional cleaning of fibres from gas, since the fibre content in gas is generally of the order of 0.02 to 0.5 g/m^3. These fibres may be re-used as well.

Thus any problem of environmental protection is efficiently solved.

The amount of gas removed from the gas/fibre stream 2 in the chamber 4 is suitably 20 to 90 percent, and is chosen in accordance with other operating conditions such as the desired mass of 1 square meter of the finished material and the length of fibres fed into the dispersing means 1.

We find that from 20 to 40 percent of the gas is to be removed in order to provide for mobility of fibres when fibrous sheet material with a high degree of structural homogeneity, having a mass of 12 to 40 g/m^2, is to be obtained from fibres having a length from 0.5 to 38 mm.

From 40 to 60 percent of gas is to be removed from the gas/fibre stream 2 where a lower mobility of fibres having length from 0.5 to 38 mm is allowable, typically when homogeneous fibrous sheet material having mass of 40 to 100 g/m^2 is to be formed.

From 60 to 90 percent of gas is to be removed from the gas/fibre stream 2 for still lower mobility of fibres in the gas/fibres stream 2, this being permissible when producing homogeneous fibrous sheet material whose mass per square meter is more than 100 g.

If the amount of gas being removed is under 20 percent, the process usually does not justify the expenditure of current, the latter drastically increasing because of considerable volume of gas to be removed per unit of time.

It is next to impossible to remove more than 90 percent of gas from the gas/fibre stream 2.

An apparatus for use in carrying out the present method for production of fibrous sheet material comprises a pipe 8 (Figure 2) interconnecting the means 1 for dispersing fibres in a gas stream and an inlet opening of the slot nozzle 3. The slot nozzle 3 has parallel side walls 9, 10 (Figure 3) which are normal to converging frontal walls 11, 12. An outlet opening of the slot nozzle 3 communicates with the chamber 4.

Installed within the chamber 4 under the frontal wall 11 of the slot nozzle 3 are guiding bodies constituted by blades 13 (Figure 2). The blades are disposed in a spaced parallel relationship one under the other, the gap 14 therebetween ranging from 20 to 3 mm in a manner which will now be described.

The gap 14 between the blades 13 is principally chosen in accordance with the length of fibres used in a layer forming process. If the fibre length is 2 mm and under, the gap 14 is chosen from 10 to 3 mm, for a fibre length equal to 20—35 mm the gap 14 is in the range between 10 and 20 mm. (A blade gap greater than 20 mm is typical when operating with the described apparatus). The blades 13 are each inclined at an acute angle α (see Figure 4) with respect to the axis of the slot nozzle 3 in the direction of the stream movement.

The angle α is chosen in accordance with the mass of the fibrous material and with the elasticity of the fibres. Where the fibres possess adequate elasticity and the mass of the fibrous material is sufficient, considerable inertia forces are generated in the gas/fibre stream 2 as it moves along the blades 13. To prevent fibre loss from the gas/fibre stream 2 occurring through the gaps 14 between the blades 13, the angle α is set close to 35. Owing to this, the fibres are repelled from the blade surfaces toward the axis of the chamber 4. Moreover, such an angle α provides additional resistance offered by the blades 13 to the gas/fibre stream 2, this resulting in intensifying the process of removing a part of the gas from the gas/fibre stream 2.

In the case where the fibres possess low elasticity and their mass is small, whereby reduced inertia forces are developed in the gas/fibre stream 2 as it moves along the blades 13, the angle α is set close to 10° in order to provide a smooth movement along the blades 13 of fibres not possessing an adequate enough elasticity to be repelled from the blade surfaces. Moreover, such an angle α offers a negligible additional resistance of the blades to the gas/fibre stream 2, thus eliminating fibre loss when the gas is being removed.

The blades 13 are fixed with their end faces to the side walls 9, 10 (Figure 3) of the chamber 4, the length of each blade being equal to the distance between the side walls 9, 10 of the chamber 4.

The blades 13 form a vertical row inclined with respect to the axis of the slot nozzle 3 at an angle β (Figure 5) chosen within the limits ranging from 3.5° to 11°.

The largest angle β is set if a steep build-up of resistance of the blades to the gas/fibre stream 2 is to be created in order to intensify the removal of gas. High intensity gas removal from the gas/fibre stream 2 may be effected only when the mass of each elementary fibre is significant, e.g. when fibres having considerable length or density (for instance asbestos fibres) are used. In this case inertia forces acting upon the fibres in the gas/fibre stream 2 are great, whereby the fibre loss with the gas being removed is negligible.

Setting the row of blades at an angle β greater than 11 contributes to an unduly intensive removal of gas resulting in appreciable fibre loss accompanying removal of gas.

If the fibres are short or possess low density, e.g. they are hollow fibres, then inertia forces acting thereon are insignificant. In this case an intensive gas removal is not permissible, since a great amount of fibrous material will be lost. Therefore, the gas removing process is to be performed with a lower intensity, i.e. a low resistance to the gas/fibre stream 2 is to be achieved. The need for satisfying these

requirements dictates the angle β be close to 3.5°.

Connected to the upper portion of the chamber 4 (Figure 2) is a branch pipe 15 for withdrawing the removed gas. The flat screen 5 is beneath the chamber 4 and the suction box 6 is disposed underneath the flat screen 5; a fibrous layer formed on the flat screen 5 is fed to a finishing means 7 where it is subjected to such after-treatment as is necessary to obtain a finished sheet material.

Figures 6, 7 show another embodiment of an apparatus for production of fibrous sheet material, wherein gas removing means for removing a part of the gas from the gas/fibre stream 2 is made as a plurality of blades 13 disposed so as to form two vertical rows, each row being located under a respective one of the frontal walls 11, 12 of the slot nozzle 3 and inclined relative to the axis of the slot nozzle at an angle ranging from 3.5° to 11°.

The blades 13 which form the row disposed under the frontal wall 11 are positioned in a mirror-image manner with respect to the blades 13 forming the row disposed under the frontal wall 12 of the slot nozzle 3. The blades 13 in each row are mounted in parallel one under the other and are spaced 3 to 20 mm apart, each blade 13 being inclined relative to the axis of the slot nozzle 3 at an angle 10° to 35° in the direction of the stream movement.

Figures 8, 9 show still another embodiment of an apparatus for production of fibrous sheet material, wherein each row of the blades 13 is divided into two sections I and II, with the section I positioned above the section II. The gap 14 between the blades 13 of the section I is set from 20 to 10 mm, while the gap 14 between the blades 13 of the section II is set from 10 to 3 mm.

Figure 10 illustrates a still further embodiment of an apparatus for production of fibrous sheet material, wherein each row of the blades 13 is divided in to four sections III, IV, V, VI. The gap 14 between the blades 13 over the section III is set within 20 to 17 mm, the gap 14 between the blades 13 over the section IV is set from 16 to 12 mm, the gap 14 for the section V is set from 11 to 6 mm, and the gap for the section VI is set from 6 to 3 mm.

The following considerations were taken into account when setting the gap distance between the blades when using sections as in Figures 8 to 10. When the gas/fibre stream 2 enters the zone of section I (Figure 8), the fibre concentration in the gas/fibre stream is low and the resistance exerted by fibrous material on the transversal flow of gas during removal is also low. Moreover, due to the high mobility of the fibres resulting from the low fibre concentration over the section I, the inertia of each fibre particle shows itself up more clearly than over the susequent sections. Owing to these effects, more intensive removal of gas is ensured in the zone of section I, and a large gap distance between the blades 13 may be provided while resulting in practically no fibre loss. The fibre concentration of the gas/fibre stream 2 increases as it passes through the zone of the section I and enters the zone of the Section II.

The resistance to the transversal gas flow rises over the section II because of increased fibre concentration. The same is responsible for the low mobility of fibres occurring under the action of inertia forces. Thus, the probability of fibre loss with gas which is being removed increases.

The gap distance between the blades 13 over the section II, however, is small, whereby the gas removal velocity becomes lower and the fibre loss is reduced.

Thus, by varying the gap distance between the blades 13 over each section, gas bleeding is controlled over the entire length of the row of blades 13.

The proposed apparatus for production of fibrous sheet material operates as follows. The fibres are supplied to the means 1 (Figure 6) for dispersing fibres in a gas stream. The gas/fibre stream 2 obtained is fed through the pipe 8 to the inlet opening of the slot nozzle 3. Due to the provision of converging frontal walls 11, 12 and parallel side walls 9, 10 (Figure 7), the cross-sectional area of the slot nozzle 3 reduces, whereby the velocity of the gas/fibre stream 2 increases as it leaves the slot nozzle 3. At the same time the gas/fibre stream 2 is contracted, this resulting in uniform distribution of its velocity field.

Upon leaving the slot nozzle 3 (Figure 6) the gas/fibre stream 2 encounters the resistance exhibited by converging rows of blades 13. As a result, the direction of movement of a considerable part of the gas changes and, being directed in to the gaps 14 between the blades 13, enters the chamber 4 and is then removed from the apparatus through pipe branches 15.

The density of fibres being much greater than that of the air, the fibres continue their rectilinear movement between the converging rows of the blades 13 under the action of inertia forces. A part of the fibres which makes contact with the blade surfaces impacts against these surfaces and, being repelled therefrom due to the blade orientation being at a certain angle relative to the axis of the slot nozzle 3, moves towards the central part of the cavity formed by two converging rows of the blades 13.

As the gas is being gradually removed through the gaps 14 between the blades 13, the fibre concentration of the gas/fibre stream 2 increases.

The converged position of the rows of the blades 13, providing for contracting the gas/fibre stream 2, contributes to an increase in degree of homogeneity of the stream.

A high fibre concentration of the gas/fibre stream 2 causes a decrease in fibre mobility.

Upon passing between the rows of the blades 13, the gas/fibre stream 2 is transformed to meet the requirements imposed thereupon to obtain fibrous sheet material of homogeneous structure, and is supplied on to the moving screen 5.

As the gas/fibre stream 2 comes into contact

with the flat screen 5, the remaining part of the gas is removed by means of the suction box 6, whereby the fibres are precipitated on the flat screen 5 to form a fibrous layer homogeneous in structure. The layer obtained is then fed to the means 7 where it is subjected to a treatment to produce a homogeneous fibrous sheet material.

The present invention is illustrated by the following non-limiting examples.

Example 1

Sheet material having a mass of 105 g/m² is to be produced from asbestos fibres of 2.5 mm mode-length:

a) fibre concentration in the gas/fibre stream	50 g/m³
b) velocity of the gas/fibre stream	10 m/s
c) cross-stream component of the gas/fibre stream turbulence intensity	20%
d) gas medium	air

The amount of gas to be removed ranges from 80% to 90%, so that a fibrous material of 105 g/m² can be obtained from short fibres.

The means for removing a part of the gas from the gas/fibre stream is embodied as a plurality of blades forming two vertical rows, each row being disposed under one frontal wall of the slot nozzle. Each blade is inclined relative to the axis of the slot nozzle at 10°, and each row of blades is inclined relative to the axis of the slot nozzle at 11°.

The abovementioned minimum angle of blade inclination and maximum angle of row inclination with respect to the slot nozzle axis are chosen in order to provide an intensive removal of gas from the gas/fibre stream as the latter is moving between the rows of blades.

Each row of blades is divided in to four sections. The first three sections, as viewed from the nozzle, are of the same length. The length of the fourth section is equal to 1.2 times the length of the first section. The gap between the blades over the first section is 12 mm, the gap between the blades over the second section is 8 mm, the gap for the third section is 6 mm, and the gap for the fourth section is 3 mm.

Due to the provision of four sections, each having a different gap distance between the blades, a smooth removal of gas from the gas/fibre stream is ensured. The loss of asbestos fibres including a considerable amount of small-sized fraction, is insignificant. Though the length of the fibres is small, the mass of the asbestos fibres is great, and therefore, the gap distance between the blades over the first section may be set much greater than the fibre length. In this case considerable inertia forces are developed in the gas/fibre stream as it moves along the blades of the first section, these forces preventing fibre loss.

The gas/fibre stream is supplied to the slot nozzle at a velocity of 10 m/s. Upon leaving the slot nozzle, its velocity increases up to 15 m/s due to the provision of the converging frontal walls. As the gas/fibre stream travels between the rows of blades, the gas is being partially removed, 50 percent of gas being removed over the first section, 30 percent over the second section, 15 percent over the third section, and 5 percent over the fourth section. (The total amount of gas partially removed from the gas/fibre stream is taken as 100 percent). The gas removed from the gas/fibre stream is delivered from the chamber through branch pipes back to the means for dispersing fibres in a gas stream. The total fibre loss does not exceed 10 percent.

As a result of removing fron 80 to 90 percent of gas, the fibre concentration in the gas/fibre stream is brought up to be in the range 250—500 g/m³, while the transversal pulsations characterized by the cross-stream component of the gas/fibre stream turbulence intensity, fall to 5—8 percent, this enabling a homogeneous gas/fibre stream structure to be obtained.

The gas/fibre stream moving with a velocity of 15 m/s is then supplied on to the flat screen which is travelling at the same velocity. The remaining gas (ranging between 10 and 20 percent) is removed by means of a suction box, thus giving on the flat screen a fibrous layer having a mass of 70 g/m². The fibrous layer is then subjected to impregnation with 3% silicon emulsion to obtain a material having a mass of 105 g/m², rolling, and drying to achieve the humidity of 2 percent. The finished sheet material possesses high thermal and electrical insulation properties and can be advantageously used in electrical engineering.

Example 2

Sheet material having a mass of 110 g/m² is to be produced from sulphate bleached cellulose, fibre mode-length being 1.5 mm.

a) fibre concentration in the gas/fibre stream	50 g/m³;
b) as a gas medium	air+ 10% CO_2*
c) velocity of the gas/fibre stream	8 m/s;
d) cross-stream component of gas/fibre stream turbulence intensity	25%

*Carbon dioxide addition to prevent explosion of the gas/fibre mixture under the action of static electric changes.

The amount of gas to be initially or pre-removed ranges between 60 and 80 percent, so that material having a mass of 110 g/m² can be obtained.

The means for removing a part of the gas from the gas/fibre stream is embodied as a plurality of blades forming two vertical rows, each row being disposed under one frontal wall of the slot nozzle. Each blade is inclined with respect to the axis of the slot nozzle at 10°, and each row of blades is

inclined with respect to the axis of the slot nozzle at 3.5°.

The abovementioned minimum angles of inclination of each blade and of the row of blades relative to the axis of the slot nozzle are chosen in order to provide an intensive removal of gas from the gas/fibre stream as the latter moves between the rows of blades.

Each row of blades is divided in to three sections of the same length. The gap distance between the blades over the first section is 11 mm, the gap distance for the second section is 9 mm, and the gap distance for the third section is 4 mm. The chosen blade-to-blade gap distances over each section ensure an intensive removal of gas without considerable fibre loss.

Cellulosic fibres typically have a smaller fraction of small-sized fibres than do asbestos fibres and hence it is sufficient to divide the rows of blades into only three sections and to carry out the removal of gas with less smoothing.

The gas/fibre stream is supplied to the slot nozzle at a velocity of 8 m/s. Upon leaving the slot nozzle, its velocity increases to 10 m/s. As the gas/fibre stream travels between the rows of blades, the gas is being partially removed therefrom, 55 percent of the gas being removed over the first section, 30 percent over the second section, and 7 percent over the third section. (The total amount of gas being partially removed from the gas/fibre stream is taken as 100 percent).

As a result of removing of 60 to 80 percent of the gas, the fibre concentration in the gas/fibre stream is brought up to 125—250 g/m³, while the transversal pulsation of the gas/fibre stream fall to 4—6 percent, this enabling a gas/fibre stream of homogeneous structure to be obtained.

The gas/fibre stream moving with a speed of 10 m/s is then supplied on to the flat screen which is travelling with the same speed. The remaining part of the gas (ranging from 20 to 40 percent) is removed by means of a suction box, thus giving on the flat screen a layer of cellulosic fibres having a mass of 90 g/m². The fibrous layer is thereafter impregnated with 3% solution of a modified maized starch to increase the mass of the material up to 110 g/m², and is then subjected to rolling and drying, whereby a wrapping paper is obtained.

Example 3

Sheet material having a mass of 40 g/m² is to be produced from viscose fibres, the fibre-mode length being 8 mm.

a) fibre concentration in the gas/fibre stream	25 g/m³
b) gas medium	air
c) velocity of the gas/fibre stream	6 m/s
d) cross-stream component of gas/fibre stream turbulence intensity	38%

The amount of gas to be initially removed ranges between 50 and 60 percent, since viscose fibres are long and since material of 40 g/m² is to be obtained.

The means for removing a part of gas from the gas/fibre stream is embodied as a plurality of blades forming two vertical rows, each row being disposed under one of the frontal walls of the slot nozzle. Each blade is inclined relative to the axis of the slot nozzle at 15°, each row of blades being inclined relative to the axis of the slot nozzle at 7°.

Since the viscose fibres do not possess adequate resilience, an inclination of the blades with respect to the axis of the slot nozzle at 15° provides for smooth slipping of fibres along the blades, while an inclination of the row of blades relative to the axis of the slot nozzle at 7° ensures a moderate intensity of gas removal from the gas/fibre stream.

Each row of blades is divided in to two sections of the same length. The blade-to-blade gap distance over the first section is 10 mm, the gap distance between the blades over the second section is 5 mm.

The gas/fibre stream is supplied to the slot nozzle at a velocity of 6 m/s. Upon leaving the slot nozzle, its velocity increases up to 8 m/s. As the gas/fibre stream passes between the rows of blades, the gas is partially removed therefrom, 60 percent of gas being removed over the first section, and 30 percent of gas being removed over the second section. (The total amount of gas so removed from the gas/fibre stream is taken as 100 percent.)

As a result of removing 50 to 60 percent of the gas, the fibre concentration in the gas/fibre stream increases from 25 g/m³, to 50—64 g/m³, while the transversal pulsations of the gas/fibre stream fall to 7 percent, due to contraction of the stream, thus providing a homogeneous gas/fibre stream.

The gas/fibre stream which is moving with the speed of 8 m/s is supplied on to a flat screen travelling with the same speed. The remaining part of gas, ranging from 40 to 50 percent, is removed by means of a suction box, thus forming on the flat screen a layer of viscous fibres, having a mass of 30 g/m², which is then impregnated with 15% water-polyvinyl acetate dispersion to increase the mass of the finished material up to 40 g/m². The material is subjected to rolling and drying to produce a nonwoven oil filtering material for use in large diesel engines.

Example 4

Sheet material having a mass of 20 g/m² is to be produced from polyester man-made fibres of 28 mm mode-length.

a) fibre concentration in the gas/fibre stream	8 g/m³
b) gas medium	ionized air
c) velocity of the gas/fibre stream	7 m/s
d) cross-section component of gas/fibre stream turbulence intensity	35%

The amount of gas to be initially or pre-removed ranges from 20 to 25 percent, since a fibrous sheet material having a mass of 20 g/m^2 is to be produced.

The means for removing a part of the gas from the gas/fibre stream is made as a plurality of blades forming one vertical row disposed under one of the frontal walls of the slot nozzle. The blade-to-blade gap distance is equal to 20 mm. Each blade is inclined relative to the axis of the slot nozzle at 35°, while the row of blades is inclined relative to the axis of the slot nozzle at 3.5°.

The abovementioned angles of inclination of each blade and of the row of blades with respect to the axis of the slot nozzle are chosen to ensure removal of a small amount of gas essentially without fibre loss.

The gas/fibre stream is supplied to the slot nozzle at a velocity of 7 m/s. Upon leaving the slot nozzle, its velocity is as high as 10 m/s. As the gas/fibre stream travels along the blades, 20 percent of the gas is removed therefrom. As a result of removing of 20 percent of the gas, the fibre concentration in the gas/fibre stream rises from 16 g/m^3 to 21 g/m^3. The cross-stream component of the turbulence intensity falls to 12 percent, due to gas/fibre stream contraction.

The gas/fibre stream moving with a speed of 15 m/s is supplied on to a flat screen moving with the same speed. The remaining part of the gas, namely 80 percent of the gas, is removed from the gas/fibre stream by means of a suction box, thus forming a layer of man-made fibres having a mass of 15 g/m^2. The layer is impregnated with a 5° solution of polyvinyl alcohol to obtain a material having a mass of 20 g/m^2, which is then subjected to rolling and drying. The finished material is a long grain paper of use in electrical engineering.

Example 5

Sheet material having a mass of 500 g/m^2 is to be produced from defibred wood fibrous particles.

a) fibre concentration of the gas/fibre stream	50 g/m^3;
b) velocity of the gas/fibre stream	8 m/s;
c) cross-stream component of the turbulence intensity	32%
d) gas medium	air

The amount of gas to be removed ranges from 85 to 90 percent, since a fibrous material having a mass over 100 g/m^2 is to be produced.

The means for removing a part of gas from the gas/fibre stream is embodied as a plurality of blades arranged so as to form two vertical rows, each disposed under one of the frontal walls of the slot nozzle, each blade being inclined relative to the axis of the slot nozzle at 30°, while each row of blades is inclined relative to the axis of the slot nozzle at 11°.

The abovementioned maximum angles of inclination of each blade and of each row relative to the axis of the slot nozzle are chosen in order to provide an intensive removal of gas from the gas/fibre stream as it flows between the rows of blades.

Wood fibrous particles as used in the process possess great mass and considerable resilience, and therefore inertia forces acting upon fibrous material are significant.

For the same reason a blade-to-blade gap distance of 6 mm is used for all the gaps. The gas/fibre stream is fed to the slot nozzle at a velocity of 8 m/s. Upon leaving the slot nozzle the velocity of the gas/fibre stream is increased up to 10 m/s.

As the stream of gas and wood fibrous particles flows between the rows of blades, a part of the gas accounting for 85—90 percent is removed. As a result, the concentration of wood fibrous particles is brought up to 334—500 g/m^3. The cross-stream component of the turbulence intensity falls, due to contraction of the stream of gas and wood fibrous particles, to 7—10 percent.

The stream is then supplied on to the flat screen in a direction normal to the plane of the screen.

The flat screen travels at a velocity of 0.8 m/s. The remaining part of the gas accounting for 10—15 percent is removed from the gas/fibre stream by means of a suction box, thus giving a layer of wood fibrous particles, having a mass of 400 g/m^3. The layer obtained is impregnated with a solution of phenolic resin so as to bring the mass of the finished material up to 500 g/m^3. The material is then cut into sheets having dimensions 3×3 m and subjected to a pressure of 60 kg/cm^2 for 20 min at 180°C.

The finished material is a fibrous construction board for use in the construction material industry.

Example 6

Woolen felt having a mass of 400 g/m^2 is to be produced from fibres of 10—35 mm mode-length.

a) fibre concentration in the gas/fibre stream	40 g/m^3
b) velocity of the gas/fibre stream	6 m/s
c) cross-stream component of the turbulence intensity	40%
d) gas medium	air
e) amount of gas to be removed	90%.

The means for removing a part of gas is embodied as two rows of blades, each row being disposed under one of the frontal walls of the slot nozzle. The blades in each row are inclined at 18°, each row being inclined at 11°.

The above mentioned angles of inclination of the elements are chosen with regard to the mass of elementary fibres and their resilience. Since the fibres are long and possess a considerable mass, an intensive removal of gas is allowable. The

resilience if the fibres is very high, therefore the angle of inclination of the blades is set at 18°.

Gap distances between the blades are the same throughout and equal to 10 mm, since the mass of each fibre is sufficient to ensure, under the action of inertia forces, a high velocity transversal flow of gas being removed.

The stream of gas and woollen fibres is fed to the slot nozzle with a speed of 7 m/s. Upon leaving the slot nozzle the steam moves at a speed of 8—5 m/s and is channelled between two rows of blades. As the stream flows between the two rows of blades, an amount of gas accounting for 88—90 percent is removed. The concentration of fibres in the gas/fibres stream is thus brought up to 410—500 g/m³. With part of the gas removed, the gas/fibre stream is supplied on to a flat screen with a velocity of 8.5 m/s at 120° with respect to the plane of the screen. The flat screen moves at a velocity of 1.35 m/s, the remaining gas being removed by means of a suction box.

As a result, a layer of fibrous material having a mass of 400 g/m² is formed on the screen.

The layer obtained is subjected to rolling.

The finished material is a felt for use in textile and construction material industries.

While particular embodiments of the invention have been shown and described in detail, various modifications thereof can be made and therefore it is not intended that the invention be limited to the disclosed embodiments or to the details thereof. Departures may be made therefrom within the invention as defined in the claims.

Claims

1. A method for the production of fibrous sheet material, comprising supply of a gas/fibre stream on to a flat screen, removal of gas from the gas/fibre stream through said screen to form a fibrous layer thereon, and any subsequent treatment necessary to obtain a fibrous sheet material, wherein a part of the gas is removed from the gas/fibre stream prior to supplying it on to the flat screen so as to bring the fibre concentration in the gas/fibre stream up to from 20 to 500 g/m³, the concentration being chosen in accordance with the kind and properties of the fibres, and transversal pulsations induced in the gas/fibre stream during movement are damped.

2. A method according to Claim 1, wherein the amount of gas removed from the gas/fibre stream prior to supplying it on to the flat screen is kept in the range between 20 and 90 percent.

3. A method according to Claim 1 or 2, wherein the transversal pulsations are damped by contracting the gas/fibre stream in the direction normal to the path of the stream movement.

4. A method for the production of fibrous sheet material, the method being substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

5. An apparatus for carrying out a method according to Claim 1 comprising a slot nozzle having side walls normal to converging frontal walls, an inlet opening of said nozzle being connected with dispersing means for dispersing fibres in a gas stream and its outlet opening being connected with a chamber, a flat screen mounted under said chamber, for forming a fibrous layer and a suction box arranged under the flat screen, wherein the side walls of the slot nozzle are in parallel relationship with respect to each other, means for removing a part of the gas from the gas/fibre stream is arranged within the chamber below the outlet opening of the slot nozzle, and the chamber is provided with branch pipes for gas exhaust which pipes are mounted substantially in the upper portion of the chamber.

6. An apparatus according to Claim 5, wherein the means for removing a part of gas from the gas/fibre stream is a plurality of guiding bodies arranged in parallel one under the other and spaced apart so as to form a vertical row disposed under one of the frontal walls of the slot nozzle and inclined at an angle ranging between 3.5° and 11° relative to the axis of the slot nozzle, each of the guiding bodies being inclined relative to the axis of the slot nozzle at an angle ranging between 10° and 35° in the direction of gas/fibre stream movement.

7. An apparatus according to Claim 5, wherein the means for removing a part of gas from the gas/fibre stream is a plurality of guiding bodies arranged in parallel one under the other and spaced apart so as to form two vertical rows, each disposed under one of the frontal walls of the slot nozzle and inclined at an angle ranging from 3.5° to 11° relative to the axis of the slot nozzle each of said guiding bodies being inclined relative to the axis of the slot nozzle at an angle ranging from 10° to 35° in the direction of gas/fibre stream movement, while the guiding bodies of one row are in a mirror-image position with respect to the guiding bodies of the other row.

8. An apparatus according to Claim 5, 6 or 7, wherein the guiding bodies are in the form of blades.

9. An apparatus according to Claim 6, 7 or 8, wherein the guiding bodies of the or each row are arranged so as to form at least two sections with equal gaps between the guiding bodies of each section, the gap between the guiding bodies of the upstream section being greater than the gap between the guiding bodies of the downstream section.

10. An apparatus according to Claim 9, wherein the gap between the guiding bodies of the upstream section does not exceed 20 mm.

11. An apparatus according to Claim 10, wherein the gap between the guiding bodies of the downstream section is not under 3 mm.

12. An apparatus according to any one of Claims 5 to 11 wherein the gap between the guiding bodies of the or each vertical row is 3 to 20 mm.

13. An apparatus for production of fibrous sheet material, the apparatus being substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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